

The Catalyst

Summer 1998

A Newsletter of the Research & Development Unit



I-40 U.S.70 Interchange, Wake County

Project 97-5, Low Maintenance Turfgrass and Cultural Management Schemes for North Carolina

Kentucky 31 tall fescue is the predominant species used along roadsides in the piedmont and western regions of North Carolina. Although tall fescue is well adapted to these regions, its vigorous upright growth and tall seedhead create the need for frequent mowing. The annual mowing cost for NCDOT roadsides is approximately \$18 million dollars. Rising mowing costs, along with often poor adaptation of the currently used species to the piedmont and western regions of North Carolina have caused the Department of Transportation to continue searching for alternative plant materials. The study's research objectives are:

- To evaluate improved selections of tall fescue and fine fescue and other promising plant materials such as centipede grass, buffalograss, zoysiagrass and other species for the cooler regions of North Carolina (emphasis on adaptability, growing height, mowing frequency and other maintenance requirements).
- To evaluate the performance of the selected and improved plant species when planted in the spring, summer, and fall.
- To screen new herbicides for plant growth regulation.
- To evaluate new and existing plant growth regulators and mixtures for use on roadsides in the cooler regions of the state.

The results of this study will be the determination and planting of improved, cost effective, and adapted plants in the piedmont and western regions of North Carolina. These results should reduce annual roadside mowing expenditures.

Project 98-2, Development of a Reliable Methodology to Determine the In-Situ Pavement Strength of General Aviation Airport Pavements

This research investigation is a joint effort between the North Carolina Department of Transportation Division of Aviation (NCDOA), the North Carolina Department of Transportation Division of Highways (NCDOT), the Federal Aviation Administration (FAA), and Roy McQueen & Associates to conduct research on the structural requirements for General Aviation (GA) airport pavements. This investigation will develop

analytical methods for the structural evaluation of flexible GA pavements. This will include standardized procedures for the nondestructive testing, evaluation, and design of airport pavement structures. This will also include developing analytical software based on layered elastic design theory. The objectives for this project are straight forward and include the following:

- To establish nondestructive testing procedures and analytical methods for GA airports.
- To estimate theoretical pavement structural life for developing rehabilitation priorities.
- To extend NCDOA's visual pavement management system to include structural analysis.

Current FAA advisory circulars and most industry publications are oriented toward pavements with large aircraft. As a result, there is a lack of definitive guidance to designers regarding evaluation and analysis of thin general aviation airfield pavements. Developing more definitive technical guidance will preclude unnecessary pavement overlays and pavement failures.

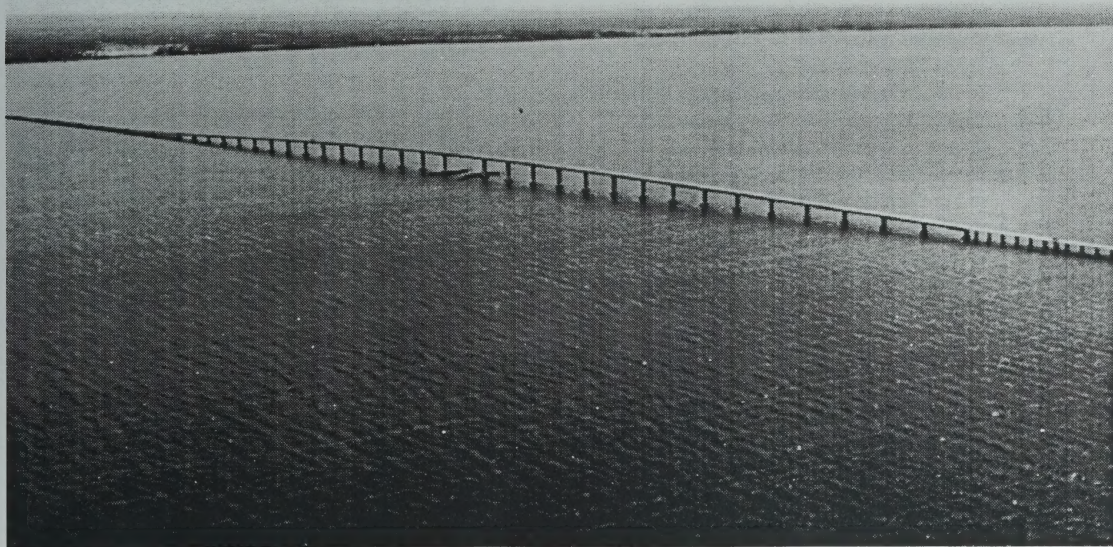
Project 98-3, Low Light Impediment to Fish Migration with Particular Emphasis on River Herring

Culverts are an economical alternative to bridge construction over small bodies of water. However, culverts are relatively narrow passages through which light penetration may be limited. This may affect the migration behavior of anadromous fishes to historical spawning sites. River herring are anadromous fishes in eastern North Carolina streams that would most likely to be impacted by culverts. The proposed study will evaluate whether culverts represent a barrier to fish migration. In particular, the effects of low light on upstream migration of adult river herring will be examined using both traditional capture techniques and acoustic sampling. The research objectives of this project are:

- To determine the efficiency of upstream passage of river herring through culverts and under bridges relative to available light at mid-span.
- To document the migration behavior of river herring in culverts and under bridges relative to available light at mid-span.



Johnston County Airport, Johnston County



U.S. 64 Croatan Sound Crossing, Dare County

- To evaluate whether increasing light levels in culverts such as grates or artificial lighting, will improve upstream passage of river herring.

This study will provide a recommendation of specific lighting requirements in culverts to allow upstream passage of river herring and other fish species. In addition, if the study results indicate that culvert design changes are needed, cost effective alternatives to artificially illuminate the inside of culverts will be considered.

Project 98-4, Erosional Scour in Coastal Sounds of Northeastern North Carolina

Scour is a known and active erosional process in the shallow waters of the North Carolina coastal sounds. The erosional effects of scour resulting from both day-to-day processes and multiple storm events are significant over time periods of decades to centuries. This has implications for bridge foundations situated in these waters. The proposed research will use Croatan Sound, a suspected high-energy erosional-scour environment, as a test case, to evaluate the processes and rates of rapid change and severe scour that have taken place over the several hundred year history of the Croatan Sound. The research project will focus on the two bridge locations in Croatan Sound: the existing US 64 crossing that was built in the early 1960's and the proposed new crossing, TIP Project R-2551. The research objectives are as follows:

- To run high-resolution seismic and ground-penetrating radar surveys and obtain an integrated network of 30-foot vibracores across Croatan Sound.
- To utilize radiocarbon age dates to define the time framework of episodes of dramatic change (deposition and scour).
- To develop a 3D-time model of the historic and prehistoric record of changes during the past history of Croatan Sound.
- To utilize the 3D model to develop the historical rates of scour for the past several hundred years and predict future scour for both Croatan Sound and the other coastal sounds where bridges are either being built or are currently in the planning stages.
- To correlate the Croatan Sound scour model to other models being developed for the North Carolina estuarine system.
- To develop the baseline framework necessary for future implementation of a long-term

monitoring system on the two Croatan bridges concerning current dynamics and associated bottom scour.

Scour is a fundamental component of all of North Carolina's shallow-water sounds. Thus, understanding the recent past history of Croatan Sound will allow the prediction of long-term bottom scour rates for all new bridges as well as those planned to be built within the coastal sounds with a minimum design life of 75 years.

Project 98-5, Non-Destructive Evaluation of Structural Condition of Timber Piles

Timber piles are one of the most commonly used sub-structures in bridge construction due to the relatively low cost of raw wood and installation. Although the economical factor is positive, the drawback to timber piles is the decay and deterioration rate of the wood (due to factors such as insects, borers, fungi, moisture, and excess weight). The objective of the proposed research is to develop a nondestructive test method for condition evaluation of installed timber piles resulting in estimation of the load capacity. To accomplish this objective, the proposed research focuses on the following:

- To develop a nondestructive test method by modifying the bending wave method currently used by the NCDOT for in-place length evaluation of timber piles.
- To develop an automated data analysis system that determines the structural condition of installed timber piles from data obtained from the test method.

The outcome of this research will be a comprehensive stress wave analysis system that will quantitatively evaluate the in-place length and structural condition of installed timber piles. It is expected that this stress wave analysis system will be put into general use by various elements of the Department.

Project 98-6, Effects of Manufactured Sand and Blended Aggregates on the Durability of Concrete Bridge Decks and Pavements

The use of manufactured sand in portland cement concrete, generally as a fraction of the fine aggregates, is already common in parts of North Carolina. This is due to the limited sources of natural fine aggregates, the increasing cost of

importing sand, and interest in optimizing fine aggregate gradations. The mixing aspect of manufactured aggregates is fairly new. Thus, blending has been limited. This investigation has two objectives:

- To help establish limits for the use of manufactured fine aggregate based on durability considerations (primary objective).
- To examine the performance and sensitivity of portland cement concrete produced with aggregate modified to achieve a specific gradation, where the modifications are produced with manufactured fines (secondary objective).

This research will provide information to the NCDOT regarding the effects of manufactured sand on the durability of concrete used in bridges and pavements. Findings may be used to develop or improve specifications for the use of manufactured sand in North Carolina bridges and pavements.

Project 98-8, In Depth Evaluation of Water Sensitivity to Asphalt Mixtures

The NCDOT is constantly concerned about stripping and other moisture induced problems in newly constructed asphalt concrete pavements. Several factors contribute to the degradation of these pavements such as traffic loading, temperature, and presence of moisture. A study is being performed to investigate these phenomena. The scope of this study includes a background investigation of previous work in the area of moisture sensitivity and specific objectives as follows:

- To identify the sources of aggregates prone to stripping and prepare mixture specimens of these aggregates with hydrated lime and two liquid anti-stripping agents, and evaluate the effectiveness of these anti-stripping agents.
- To investigate the currently used moisture sensitivity test to give repeatable and reproducible results.
- To evaluate prospective new moisture sensitivity tests.
- To recommend appropriate test parameter values for different aggregate/ anti-stripping agent combinations to be approved by the NCDOT in newly constructed asphalt pavements.

The proposed study will provide an objective evaluation of stripping potential of representative aggregate sources used in North Carolina pavements and will determine the effectiveness of different anti-stripping agents to combat moisture damage in asphalt mixtures.

Project 98-9, Developing Guidelines for the Use of Visualization in Project Design and Public Review

Visual simulation or visualization technologies have been used by transportation professionals since the 1970s. Recent advancements in computer image generation and processing capabilities are greatly improving the ability of highway design engineers and public hearing officers to visualize the designed product. These various technologies may now include computer aided design, aerial photogrammetric techniques, spatial data referencing with geographical informational systems, and satellite imagery and real time data imagery. The NCDOT has begun integrating some of these recent advances in these technologies into its pre-construction activities. The NCDOT is conducting an eighteen month study to assess the real value and utility from these latest technological enhancements, including establishing measures of effectiveness. The study's objective are:

- To monitor and document the use of three dimensional/four dimensional (3D/4D) visualization capabilities during the design and public review components of project development.
- To document the specific 3D/4D software tools used, hardware platform support, compatibility with other design hardware/software, special program support, cost of essential hardware/software, experience of user, special training required, etc.
- To aid the design engineer in selecting appropriate projects for the application of 3D/4D technology, general rules of thumb for estimated levels of effort associated with different degrees of application, guidelines for using 3D/4D representations for public hearing/review, and offer recommendations as to essential program feature, etc.

The result of this research effort will provide practical guidelines for the application of 3D/4D visualization tools and approaches for



Cherokee Skyway, Graham County

representative projects within the NCDOT, principally projects focused on Highway Design, Public Involvement, and Traffic Engineering.

Project 99-1, Full Scale Laboratory Testing of Large-Sized Long-Span Prestressed Concrete Girders with Vertical Cracking Caused by Restrained Thermal Contraction During Construction

During the production of large-sized long-span prestressed concrete bridge girders, vertical cracks often develop. These cracks mainly develop near the mid-third of the girders before the prestressing strands are detensioned. Some of the cracks may be full depth and the cracks will disappear after the prestressing strands are detensioned. The Department needs to know the effects of these early cracks on the ultimate serviceability and durability of these long girders. A study will be undertaken to investigate this phenomenon. The study objectives of this research are:

- To develop information on the fatigue behavior of cracked girders by testing two full-size girders that contain vertical cracks caused by restrained thermal contraction during their production.
- To verify the compliance with the AASHTO design provisions.
- To develop a practical analytical procedure to determine the increase of strand stress at cracked locations under repeated loadings.

The result of this project will provide the NCDOT engineers with data and information on the fatigue behavior and strength of girders with pre-existing healed cracks. The analytical procedure developed through this research will provide the NCDOT engineers a rational approach to evaluate whether a cracked girder can be accepted as being in compliance with the AASHTO load and resistance factor design (LRFD) provisions.

Project 99-2, Determination of Subgrade Strength Under Intact Portland Cement Concrete Slabs for Rubblization Projects

There are many techniques currently used by the North Carolina Department of Transportation (NCDOT) to rehabilitate cracking and aging portland cement concrete pavements. Since the late 1980s, a technique called rubblization has received increasing attention as a viable solution to minimize cracking of these pavements. But due to limited experience with this technique, there is not

a sufficient database of information to adequately gauge the performance of the rubblized section. The primary objective of the proposed research is to develop an analysis method that enables the estimation of subgrade modulus after rubblization from deflection measurements on intact PCC slabs before rubblization. The final product of this research will be a computer program that can be readily implemented by NCDOT to assist in developing rehabilitation strategies for PCC pavements. The method for realistically estimating subgrade strength under intact PCC slabs will result in more accurate assessment on preoverlay repair and overlay design. These benefits will provide better estimation of construction budgets and schedules, leading to cost and labor savings.

Project 99-3, Delamination and Shoving of Asphalt Concrete Layers Containing Baghouse Fines

The NCDOT is conducting a 12 month research study on the delamination of asphalt layers and consequent shoving and pushing of asphalt concrete mat. It is suspected that this could be affected by the presence of certain quantities of baghouse fines present in asphalt concrete mixtures.

The objective of this proposed study is to evaluate and identify the cause(s) of delamination (loss of bonding) and distortion (shoving and pushing) of asphalt concrete layers directly applicable to NCDOT Division 13. There are three factors that may affect this situation. They are:

- To avoid improper selection and application of tack coats.
- To use mixtures containing excessive baghouse fines.
- To effect moisture on the AC layer bond.

This proposed study will result in the immediate and direct cost benefit to NCDOT in terms of a repair and maintenance cost of existing distressed pavements, and will prolong the in-service life of the new or rehabilitated pavements.

Project 99-4, Dynamic Cone Penetrometer Criteria for Evaluation of Subgrade and Aggregate Base Courses

The Department of Transportation is constantly striving for the improvement of road-conditions. The Department uses soil testing techniques like the portable dynamic cone penetrometer (DCP) for

estimating the in-situ soil properties for subgrade and base layers in pavements. It has been observed that while vertical confinement by upper asphalt layers affected the DCP values of the granular pavement layers, no such effect has been measured for the DCP strength values of the subgrade layers. There is a general need to develop correlations between dynamic cone penetrometer indices and other engineering parameters such as the California Bearing Ratio (CBR) and other conventional in-situ soil properties. The overall objective of this research is to develop and validate a procedure for correlating the portable DCP data to pavement distress levels as presently evaluated by NCDOT.

The outcome of this project will be the development of an improved procedure for correlating the DCP data to the quality of the pavement subgrade and subbase.

Project 99-5, Updating Seasonal Grouping Assignments for Traffic Count Stations Using Geographic Information Systems.

The NCDOT Traffic Survey Unit wishes to improve its process for updating the seasonal grouping assignments for approximately 58,000 traffic count stations throughout the state. The updated seasonal grouping assignments are needed to prepare future-year traffic forecasts. These improved forecasts will be more useful in preparing financially feasible transportation plans. For this reason, a research study will be undertaken with the following objectives:

- To update and validate the existing seasonal roadway assignments used in the estimation of annual average daily traffic volumes.
- To update and validate the seasonal traffic adjustment factors and seasonal grouping of continuous data collection sites.
- To improve accuracy and validity of traffic demand models and traffic forecasts.
- To improve accuracy and validity of all traffic data being provided to the NCDOT, urban transportation agencies, and other transportation management systems.
- To perform system analysis and program development for improved average annual daily traffic generation.
- To conduct prototype development with Arcview and appropriate data input software.

There will be two major significant outcomes of this proposed research. The first significant outcome will be a documented statistical method to estimate the correct seasonal traffic profile of a roadway segment. The second significant outcome will be a personal computer based geographical information system application that will reduce the staff time required to check, validate, and maintain seasonal group assignments for the approximately 58,000 short term count locations.



I-40, Wake County

The Catalyst, the newsletter of the Research and Development Unit of the North Carolina Department of Transportation, is an effort to expand the outreach of the North Carolina Department of Transportation's interdisciplinary research activities and to enhance the technology transfer process. With the emphasis on applied research as promoted in the 1991 Intermodal Surface Transportation Efficiency Act legislation, the 1998 TEA-21 legislation and with the new directions that surface transportation appears to be headed during the 1990's, the maximization of all research,

development and technology transfer results in the Division of Highways is very important. Effective July 1, 1995, the Division of Highways began utilizing a management system for its research and development program. One of the essential requirements for this management system is to improve efforts to track activities, schedules and accomplishments. Reader feedback concerning any newsletter article is strongly encouraged.

Research report copies covering the various contract research studies may be obtained from Ms. Portia Jordan by calling (919)-715-2461.



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